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To cite this article: B. F. Skinner (1936) Thirst as an Arbitrary Drive, The Journal of General Psychology, 15:1, 205-210, DOI: [10.1080/00221309.1936.9917914](https://doi.org/10.1080/00221309.1936.9917914)

To link to this article: <http://dx.doi.org/10.1080/00221309.1936.9917914>



Published online: 06 Jul 2010.



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THIRST AS AN ARBITRARY DRIVE

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In experimenting upon organic behavior it is often necessary to make an arbitrary selection of a basic drive. Hunger is frequently used. Its strength is relatively easily controlled through feeding and fasting, it can be graded through a wide range of strengths, similar strengths can be obtained repeatedly, and a given constant strength can be maintained through a considerable period of time even in the event of an occasional reinforcement. In some or all of these properties it possesses advantages over such drives as sex, escape from various kinds of negatively reinforcing stimuli (cold, electrical shock), general activity, and others. Thirst resembles hunger and apparently possesses one advantage of its own. Where hunger is in reality composed of many different specific hungers (salt, sugar, and so on), which make a formulation difficult, thirst (when freed of any hunger component) is presumably uniquely related to the ingestion of water. The experiments reported here test the resulting supposition that thirst might be supposed to be preferable as an arbitrary basic drive.

In a series of experiments reported elsewhere the behavior of a white rat has been studied with respect to the factors controlling the response to a lever, where the response has been reinforced with food. Eight of these experiments have been repeated upon small groups of rats in a preliminary survey of the same reflex based upon thirst, of which four will be briefly reported here. The original work and the technique are described in the references. The only modification in the present case is that the food magazine is replaced by a device which discharges a small amount of water upon a watch crystal in the experimental box, where it is

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available to the rat. This device is a valved siphon composed of the following parts in order: (1) a reservoir of water, (2) a valve permitting a fast flow and operated by an electromagnet, (3) a branch line containing a small variable air space, (4) a constriction of the main line permitting a slow flow (say, one drop per second), and (5) an outlet 18 inches below the air space and reservoir. The amount of water delivered at each operation of the valve is determined by the air space. With the valve closed a negative pressure develops in this space, due to the weight of the water between it and the outlet. When the valve is momentarily opened, the pressure adjusts to the atmosphere, the flow at this moment through the constriction being negligible. During the subsequent few seconds a negative pressure is again developed and a measured amount of water discharged at the outlet.

Essentially maximal states of thirst can, of course, be produced by prolonged deprivation of water, or, more conveniently, by deprivation of both food and water and provision of dry food shortly before an experiment. The degrees of thirst used herein were in general considerably less than maximal and with few exceptions were obtained by allowing the rat to drink freely during a given hour each day and by experimenting just before that hour. Food was constantly available except during the experiments.

Conditioning. The original conditioning of the response to the lever can be accomplished by reinforcement with water (five cases). Evidence of a considerable amount of conditioning due to a single reinforcement is not always obtained because the effectiveness of the reinforcement may depend upon accidental aspects of the response selected, but some slight effect is usually observed and in many cases may be pronounced (1). The experiment upon this point reported in (2) was repeated upon four rats, of which one showed an even greater change than that previously reported with hunger. The record is shown in Figure 1*A*. During the first 33 minutes three responses occurred but were unreinforced. The fourth, at the arrow, is the only response in the history of the rat to be reinforced. It is followed by an extensive extinction curve, which is to be compared with Figure 1 in (2).

Extinction. This method of measuring the amount of conditioning shows incidentally the nature of the extinction curve obtained when the reflex is based upon thirst. Seven curves after considerable amounts of conditioning were also recorded. A typical curve after three successive periods during which all responses were reinforced is given in Figure 1*B* and may be compared with Figure 1 in (3).

Transfer from Hunger to Thirst. In several cases rats were taken from experiments involving hunger. A typical record from a group of seven is

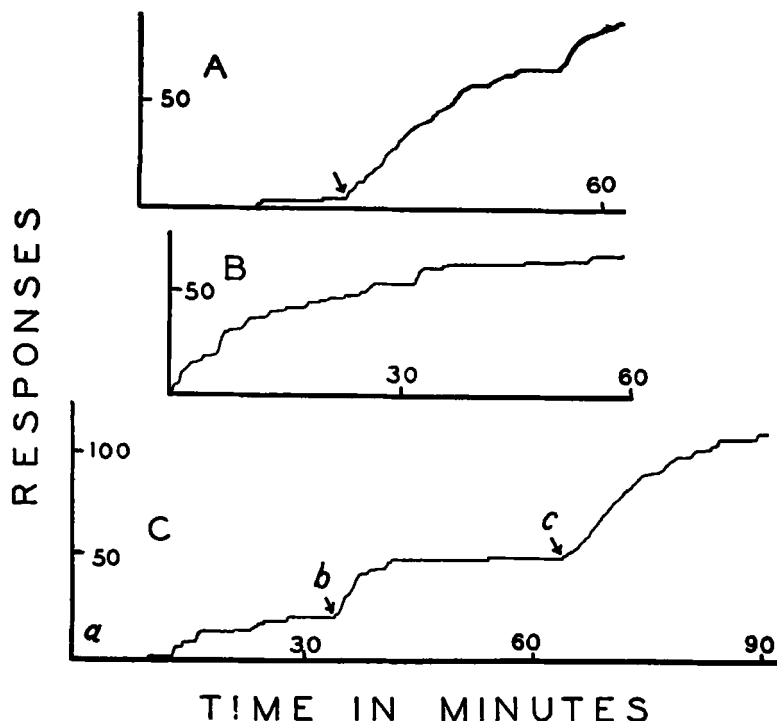


FIGURE 1

shown in Figure 1C. The rats in this group had been conditioned with food three months earlier and had developed various discriminations based upon hunger. They were then placed on a thirst regimen and trained to the sound of the magazine by reinforcement with water *in the absence of the lever*. In Figure 1C the rat was released at *a*. No water had been received by the rat in the presence of the lever prior to this experimental period. Food was constantly available (and in this experiment was present in the experimental box). The responses of the rat during the first 38 minutes were unreinforced. Since no conditioning with water had yet taken place, this initial responding may be regarded as a transfer of strength from one drive to the other. The rate shown in this figure is almost exactly the average for the seven rats (34 responses per hour). The early delay is characteristic of five records. The slight negative

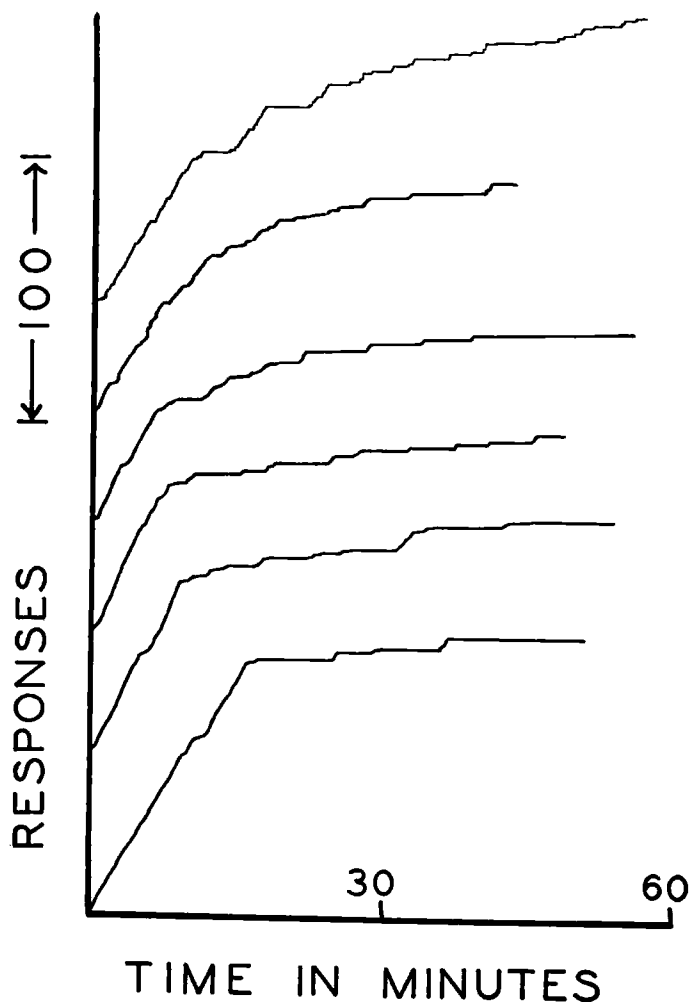


FIGURE 2

acceleration during this time is also characteristic and presumably indicates the extinction of the strength that has been borrowed from the other drive.

At *b* a single response was reinforced with water, and a subsequent extinction curve was obtained. A clearly observable effect of the reinforce-

ment of a single response appeared in all seven records. This part of the curve may be compared with Figures 1*A* and 1*B*. At *c* the reinforcement of every response was begun. A maximal rate of responding was developed and was followed by a gradual decline as the drive was weakened through drinking (see below). A marked positive acceleration may be noted at *c* as the newly conditioned reflex increases in strength. This is characteristic of all seven records and is, in general, to be observed whenever reconditioning follows extinction.

Change in Thirst as the Result of Drinking. A change in the strength of the response due to the ingestion of water may be shown simply by giving the rat free access to the lever and reinforcing every response. The resulting curves may be continuous, or they may show a single discontinuity. A series of records reaching from one extreme to the other is shown in Figure 2. The continuous curve is similar to (although not identical with) the typical curve obtained when the reflex is reinforced with food (4). No effect comparable with the discontinuous curve has been observed with hunger, although it was originally noted (5) that "a limiting factor brings each record to an end, either suddenly or after a short period of reduced frequency." The distinguishing characteristic of the present curve is the maintenance of a high rate up to the point of discontinuity.

The other experiments performed with water involved periodic reinforcement and gave essentially comparable results. But in spite of this successful repetition some reason to prefer hunger as a practical arbitrary drive appeared. The intensities of drive used in the two series were of the same order of magnitude, if we may judge from the extinction ratios, which give a convenient means of comparing the intensities of different drives (6). But the regularity of the behavior was noticeably less in the case of thirst. In particular, short periods of no responding, followed by compensatory increases in rate, occurred with greater frequency. It was also found to be difficult to produce the same strength of drive on successive days, although this may have been due solely to a failure to control the humidity of the living quarters.

A rough survey, therefore, indicates that thirst closely resembles hunger as a factor in the control of behavior but that for minor practical reasons it is not to be preferred as an arbitrary drive.

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SLEEP, WORK, AND FOOD HABITS IN THE TROPICS

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The effects of various environments upon human behavior are always interesting. The writer has recently completed a trip around the world in which he spent several months in the tropics, and during which he noticed several interesting modifications of living habits necessitated by the extreme and sustained heat.

I. SLEEP

The high degree of heat, complicated in some places by excessive humidity proves in the long run to be very debilitating. Continuous work throughout a whole day proves to be impossible. I was surprised to discover in Greece and Egypt, the first of the hot countries I visited, that all shops are closed during the early afternoon. A store may be open from 8 A.M. to 12:30 P.M., and from 4 to 7 P.M. Between these hours the workers go home and sleep about two hours. This does not represent an addition to the total amount of sleep, however. The people seemed to go to bed later and to get up earlier, on the average, than do Americans or Northern Europeans. They go to bed around midnight, yet are able to arise shortly after 6 A.M. The native quarter of a city in India is as busy at 7 as New York or London at 10 A.M.

These facts were of especial interest to the writer, as they furnished empirical corroboration to a bit of research completed just before departure on the trip (1). We had tested to see if sleep could be broken up into two four-hour installments, rather than taken in the eight-hour stretch we traditionally accept, and found that there was no measurable difference.

As to my personal reactions to the heat, I found that sleep during the afternoon eventually became necessary. I had never slept during the daytime, so attempted to go without it while in the tropics. But after a month I found myself becoming progressively more tired, and was forced to sleep, or lie down, for an hour or two in the afternoon. This seemed due both to heat exhaustion and to the heat cutting off sleep at both ends of the night.